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# Measuring congestion effects in a high-density recreational site

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# I. INTRODUCTION

Efficient resource allocation in a competitive market requires marginal cost to equal marginal benefit. However, when an externality, such as pollution or congestion, exists and is not accounted for in the decision making process, this optimization requirement cannot be met simply because of unaccounted environmental or personal benefits or costs.

A congestion externality exists when more than one user is sharing a common type of public good (also called a collective good) and interactions between users adversely affect the quality of services of the public good (Rothenberg, 1970). Congestion is an ubiquitous type of externality. Highway congestion, overcrowded beaches and long queues in front of public facilities are common types of congestion externalities. When a public facility is overcrowded, the quality of service flows obtained from the particular facility by users are deteriorated. Users have to pay the same price for lesser quality.

Quality deterioration due to congestion can be expressed in terms of time loss, safety or psychological tension of an auto trip, and reduced open space available in a picnic area or beach (Rothenberg, 1970). This quality deterioration can reduce the satisfaction an individual can derive from the public facility. Thus, an individual's willingness to pay for using the public facility can be reduced. In the aggregate the summation of all reductions in individual's willingness to pay due to congestion can be thought as the marginal social cost associated with the congestion (Cicchetti and Smith, 1976). That is, a congestion externality causes marginal social costs to differ from marginal private costs. For efficient and informed decision making, the congestion effect must be measured and accounted for in the decision making process.

Congestion effects of collective goods have become an important phenomenon impacting forest-based recreational sites and many other public facilities. One reason for this congestion is the increased demand for what these facilities have to offer. In particular, national parks, forests and preserves provide recreational opportunities that include such activities as picnicking, hiking, and viewing natural surroundings. These activities allow for "a change of pace from normal workday activities, important to individual physical and mental well-being and productive activities," (Brockman and Merriam, 1973). As the complexity of society increases, the demand for the outdoor recreation and recreational sites will also increase (Wagar, 1964).

In the United States, demand for recreation and recreational sites has increased rapidly since the 1950s. From 1954 to 1964, visits to national parks increased by 89 percent, from 18.0 million to 34.0 million visits. Visits to national forest lands also increased rapidly, from 19.7 million to 35.6 million visits, an 80 percent increase in the same period of time. This trend of rapid growth in demand for recreational sites, derived from recreational activities, is expected to continue with increased household income and technological progress causing increased leisure time (Cicchetti and Smith, 1976).

In Korea use of all eleven forest-based national parks increased from 6.9 million to 14.5 million visits; a 111 percent increase over six years, from 1976 to 1982. In the case of Book Han San National Park, located adjacent to highly populated Seoul city, the trend of rapid growth in recreational use is even more severe. Over the same time period, visits to that particular national park increased by 172 percent, from 2 million visits in 1976 to 5.6 million visits in 1982. The number of visits to that park was projected to reach 11.3 million visits in 1991 and 14.9 million visits in 1996 (Ministry of Construction, Korea, 1984).

Further, forest-based recreational resources cannot be produced by man in response to increased demand for recreational sites. These forest-based recreational sites usually have been provided by the public sector at nominal or zero prices, independent of supply and demand for the resources at the recreational site. Accordingly, along with rapid growth in demand, the congestion problem seems to be a more important phenomenon for forest based recreational site management due to the nonreproducible nature of the site. When use of a forest-based recreational site reaches a critical level of crowding, the quality of service flows obtained from the particular site by users deteriorate. The resulting marginal social cost differs from the marginal private cost. To be able to incorporate this congestion effect into the decision making process, the quality deterioration of the site users' experience must be measured and accounted for as an added cost (Cicchetti and Smith, 1976).

In view of the total economy of any nation, efficient resource allocation requires maximization of the value of services that can be obtained from a tract of forest land. This can be achieved by defining the "optimal socio-economic carrying capacity" as the optimal number of users such that the external congestion cost should be internalized, which means marginal social benefit is equal to marginal social cost. This optimal carrying capacity has important implications in natural resource allocation and management. Typically, efficient land allocation requires a comparison of the net benefits a tract of land would yield between incompatible, competitive uses. As an example, a tract of land can be used to produce an extractive industry output such as timber. Or, it can be managed to produce a collective good from the wildland recreational resources. To be able to choose between these alternative uses, we have to compare the maximum net benefit each option would yield. Then, it is necessary to determine optimal carrying capacity of the recreational site that maximizes recreational benefit obtained.

Optimal socio-economic carrying capacity is also an important tool for evaluating various management options. As Wagar (1964) indicated, a capacity augmenting investment such as laying out additional trails, which do not intersect the existing trail system, can reduce or modify the adverse effect of congestion. It is necessary to evaluate this management option to estimate the maximum benefits the recreational site would yield before and after that investment. This comparison requires, in turn, defining the optimal user density of the site before and after the capacity augmenting investment.

Concerning forest-based recreational site use, however, there is another important external cost to be considered (other than the effects of congestion), which has been called "ecological cost" (Cicchetti and Smith, 1976). For example, recreational use can cause damage to the site in terms of destruction of natural habitats and disturbance and erosion of soil. Ecological carrying capacity, which refers to how many users can be accommodated without causing any adverse effect on the natural ecosystem, is related to the "ecological cost" factor.

The optimal number of users derived from socio-economic carrying capacity consideration may be different from that determined by ecological carrying capacity consideration. In this economic analysis it is assumed that the ecological carrying capacity is greater than the socio-economic carrying capacity. That is, ecological damage to the environment is negligible until congestion works as a constraint or limiting factor so that the emphasis can be placed on measuring the effect of congestion.

As mentioned above, forest-based parks have been provided traditionally by the public sector at zero or nominal prices. That is, observable prices or user fees do not exist or are uninformative to be useful in estimating the benefits and costs associated with park use. Therefore, it is necessary to find other methods than relying on observed market transactions' data (Randall and Peterson, 1982; Fisher and Krutilla, 1972).

Historically two kinds of methods have been applied to estimate consumers' valuation of nonmarketed (nonpriced) goods such as national parks, wilderness areas, beaches, and environment improvement (reduced water and air pollution).

They are the direct and indirect methods. The indirect method is based on observable cost-quantity data in related markets.

Thus, the consumers reveal their valuation of the nonmarketed goods through related markets. The direct method uses survey instruments questionnaire to obtain individual valuations of the nonmarketed goods. After much debate about the validity of each approach, it is widely accepted that the direct method is more preferable for evaluating changes in environmental quality (Dwyer and Bowes, 1979; McConnell, 1977; Randall et al., 1974).

In this context, the purposes of this research are (1) to develop a willingness-to-pay function for individuals using a high-density forest-based recreational site by the direct method, and (2) to apply the willingness-to-pay function in a high-density forest based recreational site to aid management decisions and evaluate different use scenarios.

# II. LITERATURE REVIEW

## II-1. Theoretical Basis

The most common criterion of efficient resource allocation is that of Pareto optimality. When an economy satisfies the criterion, it is said that the economy is in a Pareto optimum at which, once achieved, nobody can be better off without making someone else worse off. When an economy is not at a Pareto optimum state, it is possible, theoretically, to make someone better off without hurting anyone else, implying some inefficiency exists in the economy. Hence, the Pareto optimality criterion is also referred to as an efficiency criterion (Just, Hueth and Schmitz, 1986).

By supposing a two-input (L, D), two output (A, N) and two-person (X, Y) situation, Bator (1957) presented how Pareto optimal conditions are determined in a general equilibrium context.

Pareto efficiency conditions for a perfectly competitive private goods market can be summarized such as:

(1) $MRS^{X}{}_{AN} = MRS^{Y}{}_{AN}$ [Exchange Efficiency]

(2) $MRTS^{A}{}_{DL} = MRTS^{N}{}_{DL}$ [Production Efficiency]

(3) $MRS_{AN} = MRT_{AN}$ [Top-Level Condition]

Exchange efficiency condition requires that the marginal valuation of a good expressed in terms of the value of other good (numeraire good) is equal for all consumers.

In a perfectly competitive goods economy, this is the price of that good.

Production efficiency condition requires that the marginal rate of technical substitution (MRTS) between two inputs (L, D) is equated for all industries using those input factors. In a perfectly competitive economy, this is equal to the price of the input factors.

The top-level condition requires that the marginal valuation of a good for a consumer is equal to marginal cost of producing the good to the society. In a perfectly competitive pure private goods economy, Pareto optimality is achieved when all of the three efficiency conditions are satisfied (Bator, 1957). In the case of public goods, however, a special case of externality, those Pareto optimal conditions derived in the framework of private goods market are no longer relevant (Cornes and Sandler, 1986; Just et al., 1982).

Samuelson (1954) indicated that the optimal provision condition of a pure public good, which corresponds to the condition (top-level condition) above for a private good, is different from that of a private good. That is, due to the inexcludability and nonrivalry between users of a pure public good, the optimal marginal rate of transformation (MRT) should be equal to the sum of marginal valuation of that public good for the whole population of the society such as:

$MRT = \Sigma\ MRS$

Except for this top-level condition, pure public goods must always satisfy production efficiency, if Pareto optimality is to be achieved. However, pure public goods do not have an exchange efficiency condition because nonexcludability of public goods precludes exchange (Cornes and Sandler, 1986).

It is difficult to find situations that have such pure nonrivalry between users as Samuelson supposed in his model. In the real world, there are many situations in which an individual's activity of using a public facility will influence those of other users.

There is a spectrum of goods and services that have purely private goods in one extreme and purely public goods in the other. Purely private goods generate utility only to the persons who consume it, therefore it can be utilized by only one person or a family. If a private good is used by one person, the same good cannot be used by others and the sum of individuals' consumption cannot exceed total product of the good (Oakland, 1972). On the other hand, a person's utilization of a public good, in a Samuelsonian sense, will not reduce the potential of other person's consumption due to the nonrivalry. Therefore, a public good can be utilized by an infinitely large number of people without reducing utilities of the person using that good

(Oakland, 1972). In the real world, there is a large array of goods that fall at any point between these two polar cases of pure private and pure public goods. It is not difficult to enumerate the list of goods and services, utilization of which by an individual entails reduced utility of the other users due to competition between users. Competition between individuals sharing a public good can be explained by supposing that an individual's activity has two effects -- one private and one public. The public effect could have either positive or negative effect to the social welfare. For example, an individual can be free from infection by immunizing himself against an infection (a private effect), while his immunity reduces the probability of transmission of the disease for the rest of his fellow citizens (Cornes and Sandler, 1986). This, then, can be thought as a public good. Alternatively, an individual's visit to a recreational site has two effects. The visitation increases his own utility value (a private effect) while it, at some critical point creates or contributes to site congestion, thereby reducing the utility value of other users. This, then, is a public bad.

Cornes and Sandler (1986) explained this situation using a joint product model originated from Lancaster. In this model, individuals use commodities in a household production process to generate final consumption service flows which one's utility depends upon.

To see how this situation alters the Pareto optimal condition, consider an individual whose objective is to choose the utility maximizing combination of y and q considering the total level of crowding, Q, arising from all consumers and subject to a budget constraint:

$$\text{Max.} \quad U^i = u[y, q, C(Q)]$$

$$\text{st.} \quad y + pq = I$$

where

$U^i$ = ith individual's utility function

y = private good

q = consumption of recreational site visit

Q = total amount of site visitation

p = price

I = income

C(Q) is a congestion function by which the total level of public effect (Z) generated with the properties of $\partial C/\partial Q > 0$, and $\partial u/\partial C < 0$ (Cornes and Sandler, 1986).

Then, society's objective can be reasonably stated as:

$$\text{max.} \quad w[u^1(.), \ldots, u^n(.)]^1$$

$$s.t \quad \Sigma y^i + p\,\Sigma q^i = \Sigma I^i$$

---

[1]The Lagrangian is
$$L = W[U^1(.), \ldots, u^n(.)] + \lambda[\Sigma I - \Sigma y - p\Sigma q^n]$$
where
$$U^i = U^i\,[y^i, q^i, C(Q)].$$
with first-order conditions of
$$q^i: \partial u^i/\partial q + \Sigma(\partial u^i/\partial C)(\partial C/\partial Q) - \lambda p = 0$$
$$y^i: \partial u^i/\partial y^i - \lambda = 0.$$

where $U^i(.) = u^i[y^i, q^i, C(Q)]$
Maximizing this social objective function with respect to $y^i$ and $q^i$ provides the first-order conditions.

$$(U^i{}_q/U^i{}_y) = p - \Sigma\,(U^i{}_c/U^i{}_y)\,(\partial C/\partial Q)$$

$$MRS_{qy} = P - \Sigma(MRS^c{}_y)\,(\partial C/\partial Q)$$

Pareto optimality requires that the marginal valuation placed by the $i^{th}$ person on the additional unit of site visitation ($MRS_{qy}$) should equal the marginal private cost, p, plus the negative effect of congestion costs imposed on all site users including himself [ $\Sigma\,(MRS_{cy})\,(\partial C/\partial Q)$]. This necessary first-order condition of optimal resource allocation (exchange efficiency condition) is different from that of a private good in a perfectly competitive market. If the individual visits the site considering only the private cost to himself, then he will not pay the social cost of congestion (Cornes and Sandler, 1986).

Alternatively, the effects of congestion externality can be accommodated more rigorously in the framework of the theory of club. Buchanan (1965) introduced the "theory of clubs" to fill the gap between the pure private goods world on the one hand and the purely public goods world on the other. Accordingly, the theory of clubs deals with those goods and services that belong anywhere between the two extreme pure private versus pure public cases and the consumption of which have public and private effects.

The optimal number of individuals sharing those goods and services is more than one person (which is the case of the pure private good) and smaller then an infinitely large number (which is the case of the pure public good) (Buchanan, 1965). Consequently, the main concerns of the "club theory" are those of determining the optimal number of persons sharing the goods and services provided and the conditions under which an individual is voluntarily participating in the sharing group (Buchanan, 1965).

Before reviewing the club theory in-depth, it is useful to comment on some characteristics of club and club goods with which the theory is concerned. One of the main features of the club is "sharing." The club members share both benefit and provision cost of partially rival (impure public) goods and services.[2] Because members are sharing the club goods, as membership size increases beyond some point, the congestion effect will take effect, causing quality degradation of the goods and services provided. And, increased membership results in benefits to the existing members by reduced share of provision expense (cost savings).

Club participation involves voluntarism. Members participate in the club voluntarily, because they expect a benefit from membership status. Therefore, the utility associated with membership status should not be less than

[2]These goods and services are termed as club goods.

that of associated nonmembership status. If this is not the case, no one will participate in a club. Club arrangements also assume the presence of an exclusion mechanism. That is, anyone who does not pay the club dues can be excluded from the club. Finally, a club arrangement involves dual decisions for each individual and collectively for the club. Because the optimal number of members and the optimal level of provision decision affect each other, it should be decided simultaneously (Cornes and Sandler, 1986).

With this preliminary knowledge, let us suppose a society that has a single club and consists of a homogeneous population of size, N, with the same tastes and initial endowments. It is further assumed that they consume two goods; a private good, y, and a club good, x. Only club participants of size "s" can consume the club good, and consequently (N-s) individuals are excluded. Then, a club participant's utility function will be

$$U[y_i, C(s, X)]$$

Where c(.) represents consumption of the club good with properties of $C_s < 0$ and $C_x > 0$. In other words, consumption of club good depends negatively on the size of sharing group due to congestion and positively on the club's provision.

The excluded members, (N-s), of society consume only private good, $y_o$, with utility function

$$U(y_o, 0)$$

To derive the Pareto optimal condition, both club members' and nonmembers' utilities should be taken into account. Then, a reasonable social objective function would be.[3]

$$\max.\ s.\ U[y_i, C(s, X)] + (N - s)\ U\ (y_o, 0)$$

$$\text{subject to } F\ [s y_i + (N - s)\ y_o, X] \leq 0$$

Where F(.) is the society's resource constraint, the first order conditions imply:

$$S.C_x MRS_{cy} = MRT_{xy} \text{ (the provision condition)}$$

$$[U(.)/Uy - U(.)/Uy] = (y_i - y_o) - S.C_s MRS_{cy}$$

(membership condition)

The provision condition for Pareto optimality for a club good with members facing congestion requires that the sum of the individual's marginal valuation of the additional club good should be equal to the marginal cost to the society of producing the additional club good. This provision

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[3]The Lagrangian is

$$L = s.U[y_i, C(s, X)] + (N - s)\ U\ (y_o, 0) + \lambda.\ F[s y_i + (N - s)\ y_o, X]$$

with first-order conditions of

$$y_i: \quad s.(\partial U/\partial y_i) - s.\ (\partial F/\partial y_i) = 0$$

$$y_o: \quad (N - s)\ (\partial u/\partial y_o) + \lambda\ (N - s)\ (\partial F/\partial y_o) = 0$$

$$X: \quad s.(\partial U/\partial C)\ (\partial C/\partial X) + \lambda(\partial F/\partial X) = 0$$

$$S: \quad U(.) - U(.) + \lambda\ F_y\ (y_i - y) = 0$$

condition is equivalent to that of Samuelson's public good case in that it requires the summation of individual valuation of the additional provision.

The membership condition requires that a change in utility due to club participation must be equal to the marginal (dis)utility on all existing members, due to the marginal entrant plus the difference in private consumption, which is required to maintain the marginal valuation of the private good between members and nonmembers. This is the condition by which the optimal number of users of a club good is determined.

## II-2. Congestion Effect on Individual Willingness to Pay

When total use of a public good reaches a certain threshold, additional users impose negative effects on existing users. That is, with congestion the satisfaction of users will deteriorate even though they pay the same cost for services obtained from the public good. Therefore, an individual's valuation of their experience is reduced. As Cicchetti and Smith (1976) properly indicated, to measure the aggregate congestion effect on a recreational site or any public facilities, a disaggregate approach, based on individual valuation, is required.

To see how congestion affects an individual's willingness to pay, suppose that the left-hand side of membership condition, derived in the previous section, equals zero.

This means the marginal club entrant's utility is held constant prior to club participation. Then, the term $(y_i - y_o)$ should be equal to the sum of the congestion cost experienced by all existing members due to the marginal entrant to meet Pareto optimality condition, such as $(y_i - y_o) = S.C_sMRS_{cy}$. Then, $(y_o - y_i)$ can have the interpretation of the maximum amount of willingness to pay as Hicksian compensating variation[4] of allowing to consume the club good.

That is, the individual is indifferent between two consumption combinations such as

$$U[y_o, 0] = U[y_o - d, c(.)]$$

Where $y_o$ is initial endowment and d the club due (Hillman and Swan, 1983). Therefore, club due (d) is the maximum amount of willingness to pay for the club participation, which depends upon the total level of congestion.

Alternatively, the conventional approach also can be used to accommodate the effect of quality deterioration on an individual's valuation for recreational site visit. One example of such a conventional approach is a model developed by McConnell (1977) of beach congestion on the south shore of Rhode Island (McConnell, 1977).

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[4]Hicksian compensating variation is defined as "the maximum of income the consumer would be willing to pay rather than relinquish" the proposed action, in this case park use (Just et al., 1982).

In this model, an individual's utility is a function of the number of visits of fixed length to the site (x), the quality of the site (q), and a composite bundle of other goods (z). Further, to define this utility maximizer's budget constraint, p represents the price of the other goods, y the individual's money income and t represents the trip cost including the opportunity cost of time of taking trip and on-site expenditures necessary for the visit. Then the individual's objective can be summarized such that:

$$\text{Max. } U(x, q, z)$$

$$\text{subject to } y - tx - pz = 0$$

From the first order conditions maximizing the objective function after forming the Lagrangian form of the utility function, we can solve for the Marshallian demand function for the site visit. This demand function implies that the individual willingness-to-pay (wp) for the site visit is a function of the individual's money income or budget (y), the quality variable (q), number of site visit (x) and the price of the other goods (p). Such that

$$wp = f(x, y, q, p)$$

This theoretical model, however, does not provide the appropriate form of the willingness-to-pay relationship. Accordingly Cicchetti and Smith (1976) suggested that "... for applied analysis one does not need to dwell on the implications of the individual utility maximizing behavior for the form of the willingness-to-pay relationship. Rather, it is possible to state that willingness-to-pay will be related to congestion, however measured" (Cicchetti and Smith, 1976).

### II-3. Method of Congestion Effect Estimation

From the preceding discussion, we know that an individual's willingness to pay is related to the quality of a recreational site denoted by "q" which can be measured by the level of congestion. The effect of congestion, however, is not captured in the market system. Therefore, we cannot use market-oriented data to estimate the change in individual willingness to pay associated with the change in congestion for a specific recreational site.

There are two methods available to evaluate a nonmarket good; the direct and indirect methods (Just et al., 1982). The indirect method uses the behavior of consumers in related markets to estimate the users valuation of nonmarket goods. The travel cost method, the best known method in the family of indirect methods, has been widely used for estimation of demand for outdoor recreation, a nonmarket good. The rationale behind this method is as follows:

Public recreation areas such as state and national parks are generally provided to the public at a nominal or zero entry price (Just et al., 1982). So, in the framework of the travel cost method, it is assumed that the travel cost to a particular recreational area dominates any entry fees. And, to estimate the site demand equation, this user-borne travel cost can be considered as the "price" of the services provided by the recreational site. From these price-quantity (number of site visits) data, we can estimate the demand for the recreation site (Just et al., 1982).

However, the travel cost method cannot be used when there is not enough variation in user origins and thus little variation in distances traveled. Insofar as there is not sufficient variation among the users' travel distance and cost, an identification problem is encountered (Just et al., 1982; McConnell, 1977; Cicchetti and Smith, 1976).

An alternative approach of measuring the benefit of nonmarket good is the direct method. This approach is to interview the individuals involved in recreation at a specific site, and, by use of a survey questionnaire, have revealed their willingness to pay for the recreational site given hypothetical congestion situations (Just et al., 1982).

This approach is not free from some potential problems, either. The problems inherent to the direct method are strategic bias, information bias, and hypothetical bias (Just et al., 1982). Strategic bias can happen when a respondent has some incentives to reveal his preference untruthfully. For example, suppose a survey is planned to determine the optimal quantity of a public good. When a respondent believes that he will have to pay for the public good at the level of what he said, there may be incentives for him to understate his valuation. His rationale for undervaluation is that he may think his contribution is relatively small when compared to the total cost of providing the public good. Thus, his contribution would not make any difference in the optimal provision decision. Also, if his valuation is nearly zero, then he can enjoy a free ride. On the other hand, when he believes that his answer will not cause him additional cost, there may be incentives to overstate his valuation, thus, enjoying greater amounts of the public good, but without a real extra charge (Cornes and Sandler, 1986).

Information bias can happen when individuals have not experienced the situations asked to evaluate by a survey. That is, the respondents do not have enough information to evaluate the hypothetical experiences. Answers given would be more likely to be incorrect (Just et al., 1982).

Another type of bias is hypothetical bias, which arises when the respondents do not understand or believe the possibility of the alternatives asked in a survey. In such cases, the answer would be more likely to be incorrect since "the respondent may simply not take the survey seriously" (Just et al., 1982).

Despite these potential problems, the direct survey method in some situations could be the only way of estimating the value of a nonmarket good. Any alternative method, such as travel cost method, is not useful when there is not enough variation in users' travel cost to estimate the site demand function. This situation is particularly true for recreational sites located close to densely populated areas.

Therefore, it seems reasonable to adapt the direct method to estimate the effect of congestion for a recreational site close to densely populated cities. Furthermore, the potential strategic bias problems inherent to the direct method seem to be less serious in a study of congestion effects at a forest-based recreational site.

As Cicchetti and Smith (1976) indicated, the primary interest of a congestion study is the change in the users' willingness to pay in response to the different levels of congestion experienced rather than the overall level of willingness to pay for the recreational experience. Even though the absolute level of willingness to pay can be biased, the primary objective of measuring the congestion effect in terms of an individual's willingness to pay, can be achieved if the "individual respondents react honestly to the changes in attributes hypothesized and if the respondent sample is sufficiently large" (Cicchetti and Smith, 1976). The other types of problems, information bias and hypothetical bias can be overcome by a carefully designed questionnaire and a careful definition of congestion (Just et al., 1982).

Cicchetti and Smith (1976 measured the effects of congestion in a low-density wilderness area by using a sample of 1970 summer users of the Spanish Peaks Primitive Area in Montana. Each individual was asked to reveal his/her willingness to pay for five hypothetical wilderness experiences. The number of encounters was used to describe the quality of the hypothetical wilderness experience. The use of this measure of congestion was based upon the findings of a previous study (Stankey, 1972) in which the most important attribute of wilderness recreation was solitude. Thus, intrusions upon solitude, it was argued, can be measured by the number of encounters with other parties; the greater the number of encounters in a given trip, the less solitude experienced. As the number of encounters increased, there was a concomitant reduction in the user's willingness to pay for the experience. Furthermore, the authors identified both the kind of party encountered and the location of their meeting. That is, they distinguished between encounters with horseback parties and hiking parties and between trail encounters and camp encounters. Thus, the five hypothetical wilderness experiences to which an individual was asked to assign his/her willingness to pay were some combination of: number of trail encounters, number of camp encounters, and mode of travel of the party encountered (Cicchetti and Smith, 1976).

Individual willingness to pay was regressed with linear and semi-log specification, on the measures of congestion, along with other socioeconomic variables to capture different preferences. The information used was obtained from 195 mail questionnaires. The semi-log specification was selected to accommodate the result of a past survey research which provided some evidence of diminishing marginal effect of encounters on individual willingness to pay (Stankey, 1972). They also estimated willingness to pay using ordinary least-squares estimator (OLS) and generalized least-squares estimator (GLS) without any test of heteroscedasticity. Following are the final results of OLS estimation with linear and semi-log specifications (Cicchetti and Smith, 1976).

$$\underset{}{WBP} = \underset{(-1.435)}{-6.609} + \underset{(5.309)}{5.163\ LN} - \underset{(-1.856)}{1.804\ TN} - \underset{(-2.326)}{2.350 CN} + \underset{(1.575)}{0.256\ FY}$$

$$+ \underset{(3.110)}{7.287\ SX} + \underset{(3.708)}{0.073\ WV} \quad (R^2 = 0.052)$$

$$WHP = -1.829 + 3.968\ LN - 2.027\ TN - 2.135\ CN + 0.138\ FY$$

$$+ 6.615\ SX + 1.069\ WV \quad (R^2 = 0.039)$$

$$\ln(WBP) = \underset{(-0.524)}{-0.214} + \underset{(3.887)}{0.934\ LN} - \underset{(-2.763)}{0.099\ LN2} - \underset{(-2.249)}{0.114\ TN}$$

$$\underset{(-4.011)}{-0.211\ CN} + \underset{(1.513)}{0.013\ FY} + \underset{(2.987)}{0.045\ WV} + \underset{(2.513)}{0.307\ SX}$$

$$(R^2 = 0.56)$$

$$\ln(WHP) = 0.219 + 0.671\ LN - 0.063\ LN2 - 0.207\ TN$$
$$(0.480)\quad (2.367)\qquad (-1.500)\qquad (-3.466)$$

$$-0.288\ CN + 0.045\ WV + 0.285\ SX\ (R2 = 0.046)$$
$$(-4.636)\qquad (2.549)\qquad (1.973)$$

where:

WBP = individual willingness to pay per trip when the encounters are with hiker parties.

WHP = individual willingness to pay per trip when the encounters are with horseback parties.

LN = length of stay of the trip in days.

TN = number of encounters on the trail per day.

CN = number of nights of camp encounters.

FY = income of the household in thousands of dollars.

WV = weeks of paid vacation.

SX = sex of the individual (1 = male, 0 = female).

$R^2$ = the coefficient of determination adjusted for degrees of freedom.

t- statistics are reported in the parentheses.

Their study illustrated the use of an estimated relationship between an individual's willingness to pay and variables which describe the quality and quantity of those experiences, and as demographic variables capturing personal preferences. One example application was to the problem of determining the optimal number of users for a particular wilderness recreation area, assuming the relationship between total number of users and the expected number of the alternative encounters is known. Another example was associated with evaluation of natural resource allocation schemes among alternative and exclusive uses (Cicchetti and Smith, 1976).

Similarly, McConnell (1977) developed a model for estimating the demand for a congested recreational site and used it to estimate individual willingness to pay functions for six beaches in Rhode Island. A direct interview approach was used in interviews with 229 swimmers to obtain information on the respondent's willingness to pay for a beach visitation on the day of the interview. The revealed willingness to pay was regressed on two site quality variables; crowd size and air temperature, along with socioeconomic variables. The actual crowd size per acre and air temperature for each interview were obtained independently by recording all entries to and exits from the beach along with air temperature, on an hourly basis. The final willingness to pay function was estimated as a function of family income, per season visits, and site quality (crowd size and temperature) with semi-log specifications such as:

$$\ln w = -4.7 + 0.00001y - 0.0025q_1 + 0.07q_2 - 0.058x$$

$$(R^2 = 0.29)$$

where:

$\ln w$ = natural log of individual willingness to pay

$y$ = family income

$q_1$ = congestion at the beach (attendance/acre)

$q_2$ = temperature at the beach

$x$ = per season visit

McConnell then demonstrated how the willingness to pay function could be used to determine the optimal capacity of beaches. The optimal number of beach users estimated was much less than the Bureau of Outdoor Recreation (BOR) standards. The author reserved judgment regarding these results due to the limitations inherent in this type of study (McConnell, 1977).

More recently, Walsh et al. (1983) investigated the effects of congestion on three downhill skiing sites in Colorado and used the results to develop procedures for project evaluation. On-site interviews with 236 skiers using a contingent valuation method was conducted. Interviewees were asked to reveal the maximum amount they would be willing to pay for lift tickets under nine different combinations of lift-line wait and number of skiers per acre. Color picture examples used of the various congestion combinations. Lift-line wait was divided into three levels such as: low lift-line wait of 1-2 minutes, medium of 12, 15, or 20 minutes, and high of 22, 30, or 40 minutes. Slope congestion was also divided into three levels such as: low slope congestion of 1-3 skiers per acre, medium of 10-15, and high of 25-40. The willingness to pay of respondents, each with 9 responses, was used to estimate a willingness to pay function which included measures of congestion, lift-line wait and skier density, and other socioeconomic variables. They also estimated condensed functions to show the relationship between willingness to pay (WTP) and two congestion measures, lift-line wait ($C_L$) and number of skiers per acre ($C_s$), holding all other independent variables constant at their mean values.

The results were:

Vail

$$WTP = 22.55 - 0.3411C_L - 0.2184C_s$$

Copper Mountain

$$WTP = 17.88 - -0.2999C_L - 0.1777C_s$$

Loveland Basin

$$WTP = 15.40 - 0.2653C_L - 0.0866C_s$$

These equations are the representative individual's willingness to pay with respect to congestion measures. As an example, a representative skier would be willing to pay $22.55 for a lift ticket at Vail if there are no lift-line wait and slope congestion. His/her willingness to pay for a lift ticket would decrease by $.34 with additional one-minute increase in lift-time wait and by $.21 with each additional skier per acre on the slope (Walsh et al., 1983).

Estimated willingness to pay functions were used to determine the optimal capacity for each site. This was done by equating the marginal aggregate willingness to pay at each level of congestion to the marginal aggregate disutility due to the additional skier. In addition, they used the willingness to pay function to estimate the external benefit of new or expanded ski areas which will enhance substitution opportunities and possibly reduce congestion at the existing site. The external benefit was estimated in terms of increased willingness to pay by those who would continue to use the existing site on peak days (Walsh et al., 1983).

In summary, even though both direct and indirect methods generrally can be employed to evaluate the site quality variable, and some researchers seem to prefer the indirect method because the "indirect method is based on what people do instead of what they say they will do" (Dyer and Hof, 1979), the direct method seems to be the preferred method in measuring the effect of congestion on a recreational site located close to a densely populated area.

## II-4. Measure of Congestion

To be able to ask an individual, using the direct method, to state the change in his willingness to pay in response to a hypothetical level of congestion, we need some description or measure of congestion which relates crowding with quality deterioration. The quality deterioration due to congestion can be described in terms of "the length of time, safety or psychological tension of an auto trip, the available area for a picnic site or a beach, the level of litter or noise, the degree of obstruction or average viewing time, of paintings, the amount of eye, lung or ear irritation in the air, or the odor, taste, bacterial count or fish population in a body of water" (Rothenberg, 1970).

However, some quality measures mentioned above cannot be used to describe the hypothetical situation to which an individual is asked to state his willingness to pay. For example, if we use the number of bacteria as a measure of congestion to describe hypothetical quality of a swimming pool in a survey questionnaire, it would not be perceptible to respondents. It makes respondents difficult to recognize how "good" is the quality described which, in turn, makes it difficult to reveal their valuation for the commodity in question. In order to reduce the potential information bias and hypothetical bias inherent to the direct method "the hypothetical situation should be realistic and credible to respondents" (Randall et al., 1974). And, this could be done by developing a perceptible and objective measure of congestion.

The measure of congestion depends on the attributes of the public good in question. For example, when the effects of congestion is time related, the amount of time lost can be used as a measure of congestion. Previous studies concerning the congestion effect in public facilities have used various measures of congestion such as the length of travel time (Boardman and Lave, 1979; Freeman and Haveman, 1979), number of encounters in a wilderness area (Cicchetti and Smith, 1976), the size of available beach space (McConnell, 1977), number of skiers per acre (Walsh et al., 1983).

In a study of measuring the cost of congestion in a low-density wilderness recreation area, Cicchetti and Smith (1976) used the number of encounters as a measure of congestion. The number of encounters describes the quality of hypothetical wilderness recreation experience to which an individual assigns his willingness to pay. Perhaps the most important attribute of wilderness recreation is solitude and intrusions upon solitude can be measured by encounters with other parties (Stankey, 1972), then the greater the number of encounters in a given wilderness trip, the less solitude experienced during it, and therefore, a lower willingness to pay. Further, the authors distinguished both the kind of party encountered and the location of their meeting. That is, they classified kind of party encountered as horseback parties and hiking parties. Trail encounters and camp encounters were used for the location of meeting.

In a study concerning effects of congestion in downhill sking sites in Colorado, Walsh et al. (1983) used combinations of lift-line waiting time and skier density per acre to describe hypothetical quality of sking sites. In their study, lift-line waiting time arranged into three categories: low lift-line wait of 1-2 minutes, medium of 12, 15 or 20 minutes, and high of 22, 30 or 40 minutes. Skier density was also arranged into three categories such as: low density of 1-3 skiers per acre, medium of 10-15, and high of 25-40 (Walsh et al., 1983).

However, density cannot be used directly to describe the hypothetical level of congestion to which respondents are asked to state their willingness to pay. The hypothetical situation such as "15 people on a ski slope" or "70 people on a ski slope" is unclear and unrealistic to the respondents. To solve this problem they developed and used color pictures to describe the quality of sking sites.

Several previous studies, facing a similar congestion and willingness to pay problem used visual aids to depict hypothetical situations of different quality of public good. Randall et al. (1974) uses three sets of pictures, each cónsists of three photographs, to depict aesthetic environmental damages associated with the Four Corners steam electric generating plant in the United States.

Set "A" showed the highest level of aesthetic and environment damage. One photograph of set A showed the plant producing its historical maximum emissions of air pollutants. Another photograph showed the spoil banks created by strip-mining and without reclamation. A third photograph showed electricity transmission lines in the landscape. Set "B" showed three photographs: (1) the power plant with reduced particulate emissions, (2) spoil banks leveled but not revegetated, and (3) transmission lines placed less obtrusively. Set C showed the minimal environmental damage with (1) the power plant with visible emissions reduced to zero, (2) a section of arid land completely reclaimed from strip-mining activities, and (3) undergrounded transmission lines (Randall et al., 1974).

Brookshire et al. (1976) also used photographs as visual aids in their bidding games intended to estimate the aesthetic damages associated with the siting of an additional power plant in the Glen Canyon National Recreation Area. Those photographs are similar to those used in Randall et al (9174).

Yet another example of visual aid used in a direct method is found in Smith et al. (1986). They used the Resource for the Future (RFF) water quality ladders shown in Figure 1 to describe water quality to respondents (Smith et al., 1986). In the study, respondents were asked to state their willingness to pay for two water quality improvements: (1) from boatable to fishable, and (2) from boatable to swimmable water quality. In addition respondents were asked to state their willingness to pay to avoid water quality deterioration to levels that would not permit any recreational uses of the water.

Using the same reasoning and quality array, video taped segments showing a representative trail of the selected Korean recreational site with about five different levels of

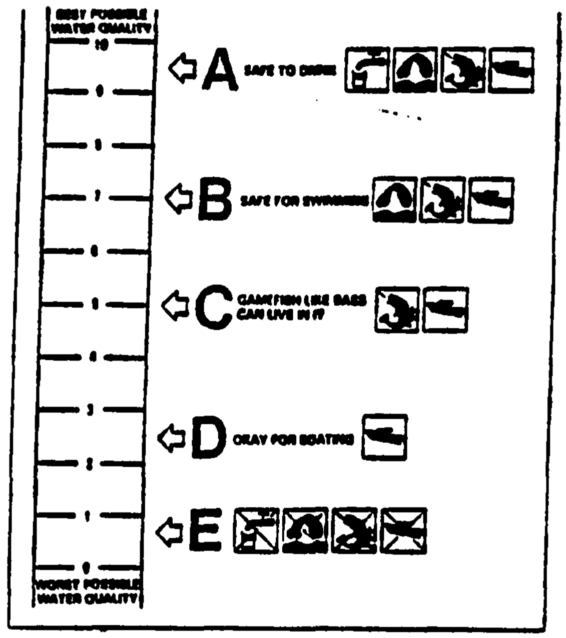


Figure 1. Water quality ladder

congestion will be developed based on the corresponding different level of user density. Then, these video taped segments will be used to describe the hypothetical situations to which the respondents are asked to assign their willingness to pay.

# III. CONDUCT OF STUDY

## III-1. Study Site

Given that the primary purpose of this study is to estimate the congestion effect of a high-density forest-based recreational site, it is necessary to define the term "high-density" explicitly. The USDA Forest Service and USDI Bureau of Land Management has adopted the concept of the Recreation Opportunity Spectrum (ROS) System for inventorying, planning, and managing their resources (Rosenthal and Walsh, 1986; Buist and Hoots, 1982).

The ROS System classifies land and water area by five criteria, in terms of the types of recreation opportunities those areas are most likely to provide. The five indicator criteria which are used to define the characteristics of the setting are remoteness, site of area, evidence of humans, user density and amount and noticeability of managerial activity or control. Using these five criteria, land and water areas are classified into one of six classes: primitive, semi-primitive nonmotorized, semi-primitive motorized, roaded natural, rural, and urban setting. Then, each ROS class provides a set of recreational experience opportunities that differ from those available in other classes. Therefore, the ROS system can be used to more precisely define recreation products such as "hiking for three recreation visitor days (RVDs) in a primitive ROS zone" (Rosenthal and Walsh, 1986).

Following is a brief description of the ROS classes (Buist and Hoots, 1982)

Primitive :
* unmodified natural environments of fairly large size(at least 500 acres) with low interaction between users.
* Motorized use is not allowed.

Semi-primitive:
* Natural and natural-appearing environments of nonmotorized at least 2500 acres with low interaction between user, but often evidence of other users.
* Motorized use is not allowed.

Semi-primitive:
* Same as above except motorized use is permitted.

Roaded :
* Natural appearing environment with moderate natural evidences of the humans.
* Interaction between users is low to moderate.
* Resource modification and utilization practices evident but harmonize with nature.
* Conventional motorized use permitted.

Rural :
* Substantially modified natural environment with sights and sounds of humans are readily evident.
* Interaction between users is moderate to high.
* Facilities are often provided for special activities
* Motorized use allowed and parking are available.

Urban :
* Urbanized environments with natural-appearing elements.
* Resource modification and utilization are aimed at enhancing specific recreation activities.
* Sights and sounds of humans are predominant.
* Large numbers of users can be expected both

on-site and in nearby areas.
* Facilities for highly intensified motor use and parking are provided.

Among these six classes of ROS, the first three classes may be defined as a low-density recreational sites, in view of user density. The next one class, roaded natural can be defined as mid-density recreational site and the last two classes, rural and urban, as a high-density recreational site.

In this context, the term "high-density recreational site" is equivalent to the rural or urban zone of the ROS system.

Book-Han-San (BHS) National Park in Korea is selected as a particular high-density recreational site for this study. BHS National Park, is one of eleven forest-based national parks in Korea. It is adjacent to the northern part of Seoul, the densely populated capital city of South Korea.

This national park is 78.45 $Km^2$ in area and was designated as a national park on April 2,1982. The characteristics of this park are similar to those in the "Rural" class of the ROS system in the "amount and noticeability of managerial activity or control" criterion, and in the "Urban" class in the "remoteness", "site of area" and "user density" criteria. In terms of "evidence of humans" criterion, it falls somewhere between "Rural" and "Urban" classes. However, motorized use is not possible because of the park's steep and rugged configuration. Thus, hiking is the predominant type of activity with picnicking and rock climbing as secondary activities on this recreational site.

Various kinds of public transportation such as buses and taxies are available from any point of Seoul and the travel cost from the city to the park is fairly low. It takes less than two hours to reach the park for any visitor from Seoul.

Visitation to the park increased from 2.05 million users in 1976 to 5.57 million users in 1982 (Ministry of Construction, Korea, 1984). Average annual rate of growth in visitation was 18.52 percent over the same period of time. This trend of increasing use of the site is expected to continue in the future. The number of users of this national park was projected to reach 11.28 million in 1991 and 14.94 million in 1996 (Ministry of Construction, Korea, 1984). This rapid growth in use of the site causes problems of congestion for park management as well as for park users. What makes the congestion problem in this national park more serious, as well as on many other forest-based recreational sites, is that park use is concentrated on weekends and holidays. Previous research showed that there were seven times as many visitors to Do Bong mountain (one portion of BHS National Park) on Sundays as there were on other days of the week. For example, the number of visitors on March 22, 1982 (a Monday) and April 17, 1982 (a Saturday) were 2,338 and 3,300, respectively. Compared to this, the number of visitors on two Sundays (March 28, 1982 and April 18, 1982) were 16,506 and 22,876, respectively (Byun, 1983). The number of visitors to the BHS National Park on Sundays and holydays was estimated about 90,000 in spring and fall seasons.

## III-2. Study Design

Determining the relationship between total number of users of a recreational site and the congestion disutilities requires definition of a measure of congestion which relates crowding to decreased utility. As an example, in a highway congestion study, time taken to complete a trip of a certain length was used as a measure of congestion. This measure of congestion (additional driving time required due to congestion) links the number of vehicles to the drivers' decreased utility (Boardman and Lave, 1979). Yet as an another example, in a low-density wilderness congestion study, Cicchetti and Smith (1976) used number of trail and camp encounters with hikers as a measure of congestion which links total number of hikers in the region to the hikers' disutility (Cicchetti and Smith, 1976). A measure of congestion depends on the services provided by the public facility in question.

Each ROS class provides somewhat different recreational experience opportunities from that of other ROS classes. And, according to Buist and Hoots (1982) "people participate in preferred recreation activities, within preferred environmental settings in order to attain satisfactory recreational experiences." Therefore, the recreational experience obtained and expected from high-density forest-based recreational site by the users may be substantially different from that of a low-density wilderness area or a high-density beach area. Accordingly, none of the congestion measures used for different settings of studies seem appropriate as the measure of congestion for the BHS National Park high-density setting.

Almost all congestion problems can be considered as a matter of density. Highway congestion can be a matter of the number of cars in a certain section of highway. Congestion in a swimming pool is the number of swimmers in a pool. That is, congestion in a public facility can be considered as the ratio of the number of users to the socio-economic or physical/biological carrying capacity of the particular public facility. In the case of a high-density forest based recreational site, user density of a trail might be a good measure of congestion.

However, density cannot be directly used in a questionnaire to describe the hypothetical level of congestion to which respondents are asked to state their willingness to pay. Hypothetical situations such as "50 people in a mile of trail" or "70 people in a square mile of park" cannot easily be perceived by the respondents.

Several previous studies, facing a similar measurement problem used photographic visual aids to depict hypothetical congestion situations. However, video tape media offer sight and sound of people. The social and psychological effects of crowding can be instantaneously measured, saved on the video tape media, and later used by trained interviewers in asking respondents to reveal their willingness to pay as they see, hear and sence various levels of congestion. This is very similar to filming the entire set of encounters for an individual and later asking them to reveal their utility value.

A video tape showing two representative trails of the BHS National Park with five different levels of congestion for each trail was developed during the summer, 1987, based on the corresponding different level of user density which were defined with the help of park management and experienced hikers. The video tape, then, was used to describe the hypothetical situation for which the respondents are asked about their willingness to pay.

On the video tape the potential user density of BHS National Park classified into five categories. Density 1 describes the situation which is likely to happen when the user density is at its lowest level. It shows a situation in which there is one other party or no other parties in sight and there is no noise heard.

Density 2 describes a situation which is likely to occur when the user density is at its next lowest level. It shows that there are 2-3 parties of other users in sight and the noise level is low.

Density 3 describes a situation which is likely to happen when the user density is at a moderate level. It shows that there are more than 3 parties of other users visible, and their conversations can be heard.

Density 4 describes a situation which is likely to happen when the user density is so high that a substantial degree of competition is expected to exist between users. It shows many users hiking along the trails in single file and with considerable noise from the users.

Density 5 describes a situation which is likely to happen when the user density is at the highest level conceivable in this park. It shows that the trail is so crowed that occasionally hiking is hindered, and the level of noise is so high that conversation within a party can be difficult. It is like an urban street scene at noon in downtown Seoul. It is expected that the congestion costs associated with degradation of the recreational experience perceived by users are very high and it is obvious that some measure of management is necessary.

In addition, individual attitudes toward the natural environment are likely to have significant effect on individual willingness to pay for use of forest based national parks. As an indicator of an individual's attitude toward the natural environment, the New Environmental Paradigm (NEP) scale developed by Dunlap and Van Liere (1978) was used. This 12 questions scale was developed to measure the extent to which persons accept concepts including man as a part of nature, limits to economic growth of a society, and the delicate natural balance of ecosystems.

Using State of Washington samples, the authors examined and reported that the 12-item scale has reliability, validity, and unidimensionality (Dunlap and Van Liere, 1978).

Even though the reliability and validity of the NEP scale were repeatedly ascertained by other replicative studies, the unidimensionality was not observed in those studies (Geller and Lasley, 1984; Albrecht, Bultena, Hoiberg, and Nowak, 1982). In a study on a sample of Iowa farmers and a sample of urban residents in Iowa, Albrecht et al. (1982) found three distinct factors emerged for both samples, termed as "Balance of Nature," "Limits to Growth," and "Man over Nature".

In a study to examine the dimensionality of the NEP scale, Geller and Lasley (1984) also observed multiple factors for a sample of Iowa farmers, of Iowa urban residents, and Missouri farmers. Using confirmatory factor analysis techniques, they found that a minimum number of four factors are needed for the data from Iowa and Missouri farmers, and five factors for the Iowa urban resident sample.

If the NEP scale is unidimensional, a high score on this scale represents greater acceptance of the concepts that man is part of the natural environment, whereas a low score indicates that man should dominate and alter, as needed, the natural environment. If the scale is multidimensional, however, then low scores can be interpreted as either a total or partial rejection of a single dimension (Geller and Lasley, 1984).

When a factor analysis was conducted for the data obtained in this study four distinct factors emerged. However, the four factor model cannot be interpreted reasonably. Therefore, based upon examination of the content of 12 items in the NEP scale, it is assumed that the NEP scale is tapping two distinct underlying attitudinal domains; (1) outlook on nature and (2) harmony in growth and environment. In testing the two factor model, a good fit for the data could not be confirmed. It was decided to retain the two factor models and remove those questions causing ambiguity. Finally, an 8-item, two factor model was obtained. The first factor is termed as "outlook on nature" and the second as "harmony in growth and environment." Table III-1 shows the items consist of each factor and factor loading of each item.

The chi-square statistic with 13 degrees of freedom is 22.4784 (P = 0.0484).

The two factor scores obtained from the reduced 8-item, two factor model are used as the indicators of respondent's attitude toward natural environment.

Table III-1. Factor analysis of the reduced NEP items

| | | Factor Loading | |
|---|---|---|---|
| Factor | Item | Factor 1 | Factor 2 |
| Factor 1 | (Outlook on Nature) | | |
| | Mankind was created to rule over the rest of nature. | .543 | -.059 |
| | Humans have the right to modify the environment to suit their needs. | .485 | .267 |
| | Plant and animals exist primarily to be used by humans. | .663 | -.109 |
| Factor 2 | (Harmony in Growth and Environment) | | |
| | We are approaching the limit of the number of people the earth can support. | .013 | .273 |
| | The earth is like a spaceship with only limited room and resource. | -.040 | .304 |
| | Humans must live in harmony with nature in order to survive. | .004 | .283 |
| | There are limits to growth beyond which our industrialized society cannot expand. | -.019 | .414 |
| | Mankind is severely abusing the environment. | .066 | .450 |

Before asking individual's for their willingness to pay, respondents were asked a series of questions about their behavior concerning forest-based recreation. In Part A of the questionnaire, they were asked about their number of annual visitations to forest-based recreational sites (not only to BHS National Park, but including other forest-based recreational sites around Seoul), their main recreational activity at the site, distance travelled from their home to the site, method of transportation used, travel time, and costs, and length of stay.

In Part B, respondents were asked to reveal their opinion about of the 12 item series of statements in the New Environmental Paradigm (NEP) Scale.

In Part C, respondents were asked to state the changes in their willingness to pay for varying levels of user density. They were shown a video tape developed with some verbal explanation, describing the situations depicted on the video tape.[1] First, they were asked how they rate the user density of the park at the time of the interview and second, what level of density they had expected to find at the park before leaving their home for the park. These questions were included to ascertain the extent to which they understood the situations described in the video tape.

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[1]Refer to the questionnaire in Appendix A.

After that, they were asked to state the change in their willingness to pay for varying levels of user density. Respondents were asked to suppose that the user density at the time of the interview corresponded to Density level 4 in the video tape, which is the second highest level of user density depicted. They were then asked to state the maximum they were willing to pay as an entrance fee for one visit to the park. Examples of entrance fees for some other recreational facilities such as a palace, swimming pool, or privately developed recreational sites were presented as a reference, ranging from 550 Won to 4,000 Won per visit ($.70-$5.00). Starting from the amount respondents were willing to pay for the user Density 4 in the video tape, the questionnaire then elicited the change in their willingness to pay for varying levels of user density, from Density 4 to Density 5, from Density 4 to Density 3, from Density 3 to Density 2, and from Density 2 to Density 1.

If a zero willingness to pay was indicated, then the respondent was asked the reason for his/her bid. Some respondents indicated that congestion does not adversely affect their recreational experience (i.e., there was no willingness to pay more for lesser user intensity) and were recorded as zero amount of willingness to pay, otherwise his/her bid of zero amount considered as a nonresponse since it could be interpreted as a protest bid.

Part D was included to collect information on the socioeconomic status of the respondents such as: sex, age, education, occupation, family size, family income, amount of vacation, and personal health.

### III-3. Willingness To Pay Model Specification and Statistical Considerations

The theoretical model discussed in Chapter II provides neither the determinants of the individual willingness to pay function, nor the functional form. However, we can infer that the utility maximizing individual's willingness to pay depends upon three groups of explanatory variables. The first group consists of variables describing the individual's resource endowment (constraint) available for the site use (visitation). It includes individual's money income, time available and the price of site use. When a public recreational site such as a state and national park is provided to the public at nominal or zero entry fee, the travel cost including the time cost to reach the site can be thought as the price of the site use.

The second explanatory group consists of variables describing quality of recreational experience provided by the site. The quality of recreational experience can be defined in terms of the physical characteristics of the setting such as beauty of scenery and the crowdedness of the site.

Concerning the quality variable, we assume that characteristics of the site, other than the level of congestion, are known and invariant across the users. This assumption can be justified given that when we focus on the congestion effect of a single site, the characteristics of an area such as the beauty of scenery, flora and fauna are unaffected by the level of use of the site assuming that the level of use is under the biological carrying capacity (Cicchetti and Smith, 1976).

The third group consists of variables, that hopefully capture the individual's different taste and attitude for site use. Demographic variables such as age, family size, health and education were used to capture the differing tastes for wilderness recreation (Cicchetti and Smith, 1976).

Summarizing the above discussion, the general form of individual willingness to pay function would be:

$$WTP_i = f(Y_i, T_i, TC_i, TT_i, Q_j, FTS_{ij}, ED_i, AG_i, FS_i)$$

where

$WTP_i$ = willingness to pay of ith individual.

$Y_i$ = money income of ith individual.

$T_i$ = time constraint for site visit of ith individual.

$TC_i$ = travel cost to the site of ith individual.

$TT_i$ = travel time of ith individual.

$Q_j$ = congestion measure, j=1,...5.

$FTS_{ij}$ = factor score of ith individual for jth factor, j=1,2.

$ED_i$ = education of ith individual.

$AG_i$ = age of ith individual.

$FS_i$ = family size of ith individual.

The economic theory does not provide any specific form of individual's willingness to pay function of recreational experience. However, previous studies of recreational site congestion suggest that the linear and semi-log relationship fit well. Cicchetti and Smith (1976) estimated both specification linear and semi-log. However, they suggested selection of semi-log specification in which the logarithm of individual willingness to pay is specified to be a linear function of the explanatory variables including the number of encounters (measure of congestion). Their selection of semi-log specification was based on Stankey's (1972) findings which indicate that the effect of congestion on individual's satisfaction depended on the total number of encounters and these encounters had a diminishing marginal effect. That is, as the number of encounters increase, the marginal effects of the encounter decrease. This diminishing marginal effect of encounters can best be accommodated by the semi-log specification.

McConnell (1977) also estimated linear and semi-log relationships to measure the congestion effect on beach user's willingness to pay and obtained similar results. However, he reported only the semi-log specification because of the posited diminishing marginal effect of the congestion variable.

Allen et al. (1986) estimated linear specification for modeling individual's willingness to pay, and willingness to accept compensation for an annual pass that would enable an individual to visit a city park.

In their recent study, Rosenthal and Walsh (1986) adopted the linear specification to predict willingness to pay for hiking. This study was conducted to estimate the net economic value of hiking in a National Forest in the front range of the Colorado Rocky mountains.

Based on past research and given the absence of a rigorous theory both linear and semi-log specifications seem to be the most promising functional forms for the high-density recreational site congestion study. The specific functional form to be estimated can be expressed in matrix form such as:

$$WTP = X\beta + u$$

where

WTP = n x 1 vector of individual willingness to pay values. (or the natural logarithm of individual willingness to pay for semi-log specification).

X = n x k matrix of explanatory variables.

$\beta$ = k x 1 vector of unknown coefficients.

u = n x 1 disturbance or error vector.

In estimating the vector of unknown coefficients, $\beta$, the following statistical assumptions of least squares regression about the probability distribution of the error term, u are made. The assumptions of the error term vector, u, are the mean to be zero, the variance to be constant, independent of exogenous variables and the various values of "u" to be drawn independently of one another.

$$E(u_i) = 0 \quad \text{for all } i$$

$$E(u_i u_j) = 0 \quad \text{for } i \neq j$$

$$= \sigma^2 \quad \text{for } i = j$$

$$V(u_i) = \sigma^2 \quad \text{for all } i$$

These assumptions allow the ordinary least-squares (OLS) coefficients $b_i$'s to be a best linear unbiased estimator of the corresponding population coefficient, $\beta$ (Johnston, 1984).

However, the cross-sectional characteristics of the data obtained in this study may raise the problem of heteroscedasticity, unequal variance of the error vector. That is, the common assumption of homogeneous variance across respondents for the ordinary least squares estimator (OLS) cannot be held. To deal with this possible problem, test of homogeneous variance will be conducted. If the data exhibit heteroscedasticity, then generalized least squares estimation (GLS) will be employed to estimate the individual willingness to pay instead of OLS.

## III-4. Data Collection

The necessary information was collected by on-site interviews during October of 1987. The interviews were conducted by two survey teams at the trial head of two different hiking trails in the BHS National Park. Each survey team consisted of three members who had received three hours of training each. Two members of a team carried out interviews of hikers and one member operated the video equipment.

All hiking parties passing through the interview point were contacted if either one of the two interviewers and the video equipment were available. One person from each party was randomly selected for the interview. When a hiking party consisted of members of two or more separate households, a member from each household was interviewed.

A total of 351 hikers was interviewed. Among them, results from 63 interviewees could not be used because they refused to (or were incapable of) complete the interview. Seventy-seven questionnaires were eliminated from the analysis due to the problem of a protest bid. Thus, 221 usable interviews were obtained and used for the analysis.

# IV. RESULTS

The characteristics of the users are summarized in Table IV-1. The average number of visitations to the mountains around Seoul, having similar characteristics to BHS National Park, is 20 times per year. Visitation ranges from 0 to 150 times per year, and about 52 percent of users in the sample do not visit more than 10 times per year.

Hiking is the dominant type of activity for about 64 percent of users on the site, and rock climbing, the next dominant type of activity, accounts for about 16 percent of users.

On the average, site users traveled 10 to 15 Km to reach the site. Sixty seven percent of users traveled less than 20 Km. Average one-way travel time to the site is 40 to 50 minutes with 840 Won of travel cost. About one half of the users paid less than 490 Won for transportation cost. This relatively small amount of travel cost can be explained by the fact that about 70 percent of site users used public transportation, such as buses and/or subways.

Users younger than 39 years old account for about three quarters of the users in the sample. Only 1.8 percent of users in the sample were older than 60. This can be explained by the steep and rugged configuration of the site.

About one half of the users in the sample completed 16 years or more of formal education and about 95 percent of the users completed more than 12 years of formal education.

Average family size of the site users was 5 persons. About 90 percent of users came from families of less than 6 persons. The average family income for the sample was 600 to 800 thousand Won per month. The average number of days per month available for site visitation was 5 days. About 82 percent of users in the sample have no more than 5 days off

Table IV-1. Average BHS National Park User Characteristic (The sample size varies from 220 to 221.)

| Characteristic | Unit | Average value |
|---|---|---|
| Number of site visit | Visits/year | 20 |
| Distance to the site | Km | 10 - 15[a] |
| Travel time (one-way) | Minutes | 40 - 50[a] |
| Travel cost (one-way) | Won[b] | 840 |
| Duration of stay | Hours/visit | 4 - 6[a] |
| Age | Year | 30 - 34[a] |
| Education | Year | 14[a] |
| Family size | Person | 4.6 |
| Family income | Won/month | 600,000 - 800,000 |
| Number of day-off | Days/month | 5 |

[a]Categorized value.
[b]Monetary unit of Korean currency (with exchange rate in Oct. 1987 of $1 to 750 Won approximately).

per month. The number of days available for recreational activities is limited because most people work on Saturdays, leaving only Sundays for leisure activities.

The primary variables in this study are shown in Table IV-2. Various combinations of these explanatory variables

Table IV-2. Definition of Variables

| Variable | Unit | Expected Sign | Description |
|---|---|---|---|
| WTP | Won[a] | ____[b] | Individual willingness to pay per use to BHS National Park |
| UD | 1-5 | - | User density in terms of video tape developed: low user density = 1, higher user density =5 |
| ENVR1 | _[c] | +, ? | Factor score for "Outlook of nature" factor |
| ENVR2 | _[c] | +, ? | Factor Score for "Harmony in growth and environment" factor |
| FI | Won/month | + | Family income per month |
| DA | Days/month | - | Number of days off per month |
| TC | Won | - | Travel cost to the site |
| TT | Hour | - | Travel time to the site |
| NV | Days/year | +, ? | Number of site use per year |
| ED | 1-6 | ? | Education of respondent: low education = 1, high education = 6 |
| FS | Person | ? | Family size |

[a]Monetary unit of Korean currency.
[b]Dependent variable.
[c]Standardized factor score.

are regressed on individual willingness to pay (WTP) with linear and semi-log specification of the dependent variable.

Family income per month, FI, and travel cost to the site, TC, were expected to have significant positive and negative effect on the individual WTP for site use, respectively. However, these variables were never observed to have a significant effect or have the correct signs. This can be explained by the fact that the total expenditure for a site visitation and the total travel cost represents a very small portion of their total monthly family income.

Table IV-3. Linear Willingness to Pay (WTP) Function

| Variable | Coefficient | Standard Error | t[a] |
|---|---|---|---|
| UD | -719.315 | 103.637 | -6.941*** |
| ENVR1 | 698.313 | 190.906 | 3.658*** |
| ENVR2 | 1049.354 | 213.681 | 4.911*** |
| NV | 19.496 | 6.950 | 2.805*** |
| TT | 217.170 | 69.186 | 3.139*** |
| ED | -221.421 | 131.546 | -1.683* |
| FS | 376.647 | 94.709 | 3.977*** |
| DA | -77.744 | 40.322 | -1.928* |
| Intercept = 3251.118, $R^2$ = 0.10 | | | |

[a]Student t-ratios for the null hypothesis.
*Significantly different from zero at 90% confidence level.
***Significantly different from zero at 99% confidence level.

Thus, there is apparently little effect on individual WTP from FI and TC.

Accordingly, these variables were eliminated from further analysis and the general form of individual WTP function is expressed in the following way:

WTP = f(UD, ENVR1, ENVR2, NV, TT, ED, AG, DA),

where the variables are defined as Table IV-2. The final results of estimation with linear and semi-log function are

Table IV-4. Semi-log Willingness to Pay (WTP) Function

| Variable | Coefficient | Standard Error | t[a] |
|---|---|---|---|
| UD | -0.273 | 0.025 | -11.114*** |
| ENVR1 | 0.161 | 0.044 | 3.648*** |
| ENVR2 | 0.295 | 0.050 | 5.914*** |
| TT | 0.036 | 0.016 | 2.237** |
| ED | -0.058 | 0.031 | -1.885* |
| FS | 0.069 | 0.022 | 3.141*** |
| DA | -0.016 | 0.010 | -1.718** |
| Intercept = 7.903 | $R^2$ = 0.15 | | |

[a]Student t-ratios for the null hypothesis.

*Significantly different from zero at 90% confidence level.

**Significantly different from zero at 95% confidence level.

***Significantly different from zero at 99% confidence level.

presented in Table IV-3 and Table IV-4, respectively.

In the linear specification, the hypothesis that regression coefficients of all variables included in the equation are unrelated to willingness to pay can be rejected at 90 percent to 99 percent confidence level. The sign of the coefficients of all independent variables included in the equation are consistent with *a priori* expectations.

When user density increases, *ceteris paribus*, by one level, say from 1 to 2, then individual WTP for site use decreases on average approximately 719 Won as one would expected. The environmental factor score variables, ENVR1 and ENVR2, as indicators of an individual's attitude toward the natural environment are expected to exert a positive and direct effect on individual WTP. That is, as one is more accepting of the concepts of including man as a part of nature, that there are limits to economic growth, and there is a delicate natural balance of ecosystems, he is willing to pay more for the forest-based recreational use. WTP also depends on the time available for site use. The independent variable of the number of off-duty days per month, DA, has a significant, negative effect on the WTP. This can be explained by assuming that if one has less time available for leisure activity, then his marginal valuation of that time will be higher than that of a person having more time available. In other words, one who spends higher valued time at a recreational site would place higher value on the recreational experience obtained from the site use, and thus would be willing to pay a higher money price.

Travel time was expected, *a priori*, to have a negative effect on WTP. Travel time can be thought of as a time price for using a recreational site in addition to the direct cost of site use and those who already pay a higher price with respect to travel would be willing to pay less for site use assuming WTP as an index of consumer surplus.

However, in this study it turns out that travel time taken to reach the site has a significant positive effect on individual WTP. This can be explained with the fact that there are few available substitutes for the forest-based park recreational experience hiking provided by BHS National Park. Persons who are willing to pay more time cost for the site visitation are also willing to pay a greater amount of money to enter the park.

The signs for demographic variables included in the equation, education (ED) and family size (FS), were difficult to anticipate. Education has a negative effect on WTP. It may be that an individual who has an higher education places less value on recreational site use. Family size has a positive effect on WTP. Individuals who come from a larger family are willing to pay more than those from a smaller family.

In the equation of semi-log specification, all signs for the coefficients included in the equation are the same as those in the linear specification equation except that of the number of site visitations per year variable, NV. This variable is not included in the semi-log equation because the hypothesis that the regression coefficient for the variable is equal to zero can not be rejected at the 90 percent confidence level.

The coefficient of determination, $R^2$ , adjusted for the degrees of freedom of the linear equation is 0.10 and that of semi-log equation is 0.14. Both are relatively low, yet "good" given the cross-sectional data.

These two $R^2$ values cannot be directly compared because the scale for the dependent variables, WTP for the linear specification, and logarithm of WTP for the semi-log specification, is not the same. Overall, both equations are significant at the 99 percent level of significance with the F-value of 15.7 for linear specification and 23.7 for semi-log specification.

Again, economic theory is not very helpful in choosing the specific functional form of WTP between the linear and the semi-log forms. A linear specification implies that an increase in user density has the same impact at each level of user density, whereas the semi-log specification implies that an increase in user density has the same percentage effect, the proportionate rate of change in WTP per unit change in user density is constant[1]. As an example, the estimated coefficient for user density, UD, implies that one unit increase of the user density reduces the individual WTP by about 27.3 percent. Thus, as the level of WTP declines, so does the absolute magnitude of the effect. This means that each additional user density has diminishing marginal effect on individual WTP (Johnston, 1984; Cicchetti and Smith, 1976). This diminishing marginal effects of user density was confirmed by previous studies. McConnell (1977) used a semi-log specification to accommodate the diminishing marginal effects of congestion variable in his beach congestion study (McConnell, 1977). Cicchetti and Smith (1976) also suggested their preference of semi-log specification because it permits the marginal effects of the number of encounters (congestion measure) to change as the level of congestion changes.

Cross-sectional data used in this study are known to be subject to the problem of heteroscedasticity of the disturbance term. That is, the constant variance assumption, $E(u^2) = \sigma^2$, made in previous chapter is not satisfied, if heteroscedasticity exists. Accordingly, a test of homogenous variance was conducted using Glejser's test[2]

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[1]Semi-log model $\ln Y = \alpha + \beta X + u$ or $Y = e^{\alpha + \beta X + u}$ gives $(1/Y)(dY/dX) = \beta$ [Johnston, 1984].

[2]In doing the test, it was presumed that the user density variable is the source of heteroscedasticity.

(Glejser, 1969). In the case of semi-log specification, the hypothesis of homoscedasticity cannot be rejected. In the case of linear specification, however, the hypothesis of homoscedasticity was rejected. Consequently, it seems useful to apply generalized least square (GLS) estimation method. In doing that, the user density variable (UD) was postulated as the source of heteroscedasticity.

The results of GLS estimate for the equations used in OLS estimations are reported in Table IV-5 and Table IV-6 for linear and semi-log specification, respectively. The coefficients of determination ($R^2$) obtained by GLS estimations are much higher than those obtained by OLS estimations. However, these are not directly comparable since dependent and independent variables used in GLS are transformed (Cicchetti and Smith, 1976).

Table IV-5. GLS Estimations of Linear Willingness to Pay (WTP) Function

| Variable | Coefficient | Standard Error | t[a] |
| --- | --- | --- | --- |
| UD | -670.080 | 186.862 | -3.586*** |
| ENVR1 | 802.334 | 241.243 | 3.326*** |
| ENVR2 | 1406.488 | 270.024 | 5.209*** |
| NV | 27.565 | 8.783 | 3.138*** |
| TT | 282.672 | 87.429 | 3.233*** |
| ED | -212.050 | 166.232 | -1.276* |
| FS | 520.226 | 119.682 | 4.347*** |
| DA | -102.987 | 50.954 | -2.021* |
| Intercept = 2030.430, $R^2$ = 0.32 | | | |

[a]Student t-ratios for the null hypothesis.
*Significantly different from zero at 90% confidence level.
***Significantly different from zero at 99% confidence level.

Table IV-6. GLS Estimates of Semi-log Willingness to Pay (WTP) Function

| Variable | Coefficient | Standard Error | t[a] |
|---|---|---|---|
| UD | -0.214 | 0.035 | -6.115*** |
| ENVR1 | 0.116 | 0.044 | 2.637*** |
| ENVR2 | 0.320 | 0.050 | 6.461*** |
| TT | 0.039 | 0.016 | 2.388** |
| ED | -0.058 | 0.031 | -1.885* |
| FS | 0.080 | 0.022 | 3.632*** |
| DA | -0.017 | 0.009 | -1.794** |
| Intercept = 7.765 | | $R^2$ = 0.98 | |

[a]Student t-ratios for the null hypothesis,

*Significantly different from zero at 90% confidence level.

**Significantly different from zero at 95% confidence level.

***Significantly different from zero at 99% confidence level.

# V. APPLICATION OF THE RESULT

To be able to use the empirically estimated results to aid in the management of BHS National Park, the relationship between total number of users and the congestion measure, the user density level, needs to be defined. Cicchetti and Smith (1976) suggested three approaches of obtaining the relationship. These are (1) relying on the experience judgement of park managers, (2) empirically estimating use-congestion measure (i.e., perceived user density) relationship and (3) constructing a stochastic simulation model of use-congestion relationship (Cicchetti and Smith, 1976).

The first approach implies assuming a functional relationship between number of users and perceived user density. Obviously, this approach could be of limited value because it cannot be "proved." However, the second and the third approach require substantial amounts of money and time resources[1]. Accordingly, the first approach, relying on the judgement of the experienced observers was the only available basis for establishing the relationship between total number of users and perceived user density, represented by five

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[1]Byun (1983) indicated that counting the total number of users of a forest-based recreational site required about 60 persons for one single counting day.

different level of user density in the video tape.

Several park management officers and rescue crew members staying in the park were contacted at the interview sites and the park management office. According to the information obtained from the park managers and rescue crew members, there is a linear relationship[2] exists between user density level shown in the video tape and total number of userswas developed. The expert opinions yielded the following linear relationship.

$$UD = 0.00005\ N \qquad (5\text{-}2)$$

where: UD = level of user density shown in the video tape. Recall that UD = 1 is a low density of use (i.e. low congestion effects).

N = total number of users.

This relationship was accepted as a plausible approximation by experienced hikers who are use the park frequently. Then, given this relationship it is possible to determine optimal number of users by using the estimated WTP relationship.

When we take a total-economy view point, the Pareto optimality criterion requires the total (or aggregate) WTP obtained from a recreation site to be maximized. The

[2]This relationship implicitly assumes that the perceived user density is unvarying by the characteristics of other user and that the length of stay of each user is constant.

aggregate willingness to pay can be represented as:

$$AWTP = \Sigma f(UD, ENVR1, ENVR2, TT, ED, FS, DA) \quad (5\text{-}3)$$

where: AWTP = aggregate willingness to pay

f(·) = willingness to pay of ith person.

If we assume that all users are identical in their tastes and endowments, the aggregate process will be simplified as:

$$AWTP = N \cdot g(UD) \quad (5\text{-}4)$$

where: N = total number of park users.

g(·) = representative individual's WTP for an individual.

In g(·), all other explanatory variables are held constant at their mean values to show the relationship between WTP and the user density variable of interest. Then, g(·) can be interpreted as the average or representative individual's WTP function expressed in terms of user density, UD. The park manager's objective function can be represented in the following way:

$$\text{Max. } AWTP = N \cdot g(UD) \quad (5\text{-}5)$$

Using the relationship between total number of users, N, and user density variable, UD, as defined in equation 5-2, the first order necessary condition is given as:

$$N\,\partial g(\cdot)/\partial N + g(\cdot) = 0 \tag{5-6}$$

Solution of this necessary condition with respect to N gives us optimal number of users.

Using the semi-log function estimated in Chapter IV and the mean values for all independent variables except user density, the following condensed equation can be derived:

$$\ln(WTP) = 8.044 - 0.273UD. \tag{5-7}$$

Substituting equation (5-2) into (5-7) gives equation (5-8).

$$\ln(WTP) = 8.044 - 0.273(0.00005\ N) \tag{5-8}$$

Then, the aggregate willingness to pay will be:

$$AWTP = N \exp(8.044 - 0.00137\ N). \tag{5-9}$$

Maximizing equation (5-9) with respect to total number of users, N, gives about 73,260 persons per day as the optimal number of users for BHS National Park. At this level of user density, the gain in aggregate WTP from one additional user is equated to the sum of disutility experienced by all other users due to the congestion generated by the marginal user. The optimal user number estimated in this study falls somewhere between user density 3 and user density 4 as recorded on the video tape.

Because the level of the user density during most Sundays is higher than user density 4 shown in video tape, a substantial degree of congestion cost is involved in the use of this park. However, it must be noted that, as Wagar (1964) indicated, the optimal number of users estimated is not an absolute value inherent to the particular recreational site. The optimal number of users can be increased without adversely affecting recreational quality by management procedures that (1) reduce conflicts between competing uses, (2) reduce the destructiveness of users, (3) increase the durability of the site, or (4) provide increased opportunities for enjoyment. Wagar (1964) suggested zoning, engineering, public relations and persuasion, interpretive services and management of biotic communities as management procedures which can augment carrying capacity.

Zoning can reduce congestion disutility by reducing conflicts and efficiently using land resources. Additional trails which do not intersect existing trails and control the movements of people can increase carrying capacity without recreational quality deterioration. Publicity and other means of persuasion, such as environmental education, can also increase carrying capacity by reducing the destructive behavior of users (Wagar, 1964).

Any management procedure undertaken to augment carrying capacity can be evaluated by using an estimated WTP function. If the cost of the management procedure is less than the benefit gained from that management procedure by all of the users, then it can be "justified".

# VI. SUMMARY

Congestion is a type of externality that causes marginal social benefit (MSB) to differ from marginal social cost (MSC). For efficient resource allocation, the congestion effect should be measured and accounted for in the decision making procedure.

Congestion in a forest-based recreational site seems more important not only because of rapid growth in site demand, but also because the recreational site is not producible by man. Further, forest-based recreational sites usually have been provided by the public sector at nominal or zero prices, independent of supply and demand for the resources. Therefore, no price mechanism exists to control effectively the supply of and demand for recreational site.

When congestion exists in a recreational site, the quality of the recreational experience obtained by users deteriorates causing reduced willingness to pay by users. The sum of reduction of individual willingness to pay can be thought os as a marginal social cost associated with a specific level of congestion for a specific recreational site (Cicchetti and Smith, 1976).

In this context, the purposes of this research are (1) to estimate a willingness to pay function for an individual using a high-density forest-based recreational site and (2) to apply the willingness to pay function to aid in the management of the Book Han San National Park in Korea.

The change in individual willingness to pay in response to different level of congestion in a recreational site can be explained by the theory of club as well as conventional modeling approaches for consumer behavior. That is, the congestion effect can be captured by the individual demand for the site visit derived by maximizing his utility function subject to budget constraint (McConnell, 1977).

To estimate the congestion effect, however, we cannot use market-oriented data because congestion is not a market good. There are two kinds of methods available to evaluate a nonmarket good; the direct and indirect methods. The indirect method uses the behavior of consumers in related markets to estimate the users' valuation of non-market good. The direct method is to ask individuals to reveal his or her willingness to pay for the hypothetical situation of varying degrees of congestion for the recreational site (Just et al, 1982). Even though both methods generally can be used to evaluate the site quality variable, the direct method seems to be the only practical method in some situations and that is the case for the empirical study (McConnell, 1977; Cicchetti and Smith, 1976).

To be able to ask an individual, using direct method, to state the change in his willingness to pay, it is necessary to describe the congestion situation objectively and perceptibly. None of the descriptions of congestion (or measure of congestion) used in previous studies seem to be appropriate for use in a high-density recreational site. To solve this problem, a visual aids, specifically using video taped segment, were developed, in which five different levels of trail congestion were described in terms of perceived user density and noise level on two different trails of varing route.

Using ordinary least square (OLS) and generalized least square (GLS) methods, individual willingness to pay was regressed on various independent variables representing site quality, recreational behavior, attitude toward natural environment and socio-economic status with linear and semi-log specifications. Among four equations estimated and reported in Chapter IV, OLS semi-log specification was used for the further discussion of an application of the estimated willingness to pay relationship.

The final willingness to pay equation estimated with OLS semi-log specification is:

$$\begin{aligned} \ln(WTP) = 7.903 - 0.273\ UD + 0.161\ ENVR_1 + 0.295\ ENVR_2 \\ + 0.036TT - 0.058\ ED + 0.069\ FS - 0.016\ DA \\ (R^2 = 0.15) \qquad (6 - 1) \end{aligned}$$

Where the variables included are defined in Table IV-2.

Then, the willingness to pay function was used to determine the optimal number of users for the particular park.

In doing that, the relationship between the user density, UD, and number of users, N, was assumed such as:

$$UD = 0.00005 N \qquad (6 - 2)$$

Further, semi-log willingness to pay function was condensed in the way that all independent variables other than user density, UD, are fixed at their mean values.

The condensed equation is :

$$\ln(WTP) = 8.044 - 0.273 \, UD \qquad (6 - 3)$$

This equation indicates that the proportionate rate of change in WTP per unit change in user density (UD) is a constant and equal to -27.3 percent.

Using the relationships (6 - 2) and (6 - 3), optimal number of users was estimated as about 73,000 users per day. This figure is much less than the current number of users on most Sundays during the spring and fall seasons. However, it was noted that the optimal number of users estimated is not an absolute value inherent to the particular recreational site. Rather, it can be increased without any recreational quality deterioration by carrying capacity augmenting management procedures.

# VII. REFERENCES

Albrecht, D., Bultena, G., Hoiberg, E. and Nowak, P. 1982. The New Environment Paradigm Scale. Journal of Environmental Education 13: 39-43.

Allen, P. G., Stevens, T.H., Yocker, G. and More, T. 1986. The Benefits and Costs of Urban Forest Parks. Dept. of Agriculture and Resource Economics, University of Massachusetts and USDA Forest Service Northeast Forest Experiment Station Research Bulletin No. 709.

Bator, F. M. 1957. The Simple Analytics of Welfare Maximization. American Economic Review 47: 22-59.

Boardman, A. E. and Lave, L. B. 1979. Highway Congestion and Congestion Tolls. Journal of Urban Economics 4: 340-59.

Brockman, C. F. and Merriam, L. C., Jr. 1973. Recreational Use of Wild Land. 2nd ed. McGraw Hill Book Co., New York.

Brookshire, D. S., Ives, B. C. and Schulze, W. D. 1976. The Valuation of Aesthetic Preferences. Journal of Environmental Economics and Management 3 (1976): 325-346.

Buchanan, J. M. 1965. An Economic Theory of Clubs. Economica 32: 1-14.

Buist, L. J. and Hoots, T. A. 1982. Recreation Opportunity Spectrum Approach to Resource Planning. Journal of Forestry 80: 84-85.

Byun, W. H. 1983. Verhaltenswisen und Einstellungen Der Einwohner Von Seoul/Korea Zu Ihrer Forstlichen Umwelt. Dissertation Zur Erlangung Des Doktorgrades.

Cicchetti, C. J. and Smith, V. K. 1976. The Cost of Congestion: An Econometric Analysis of Wilderness. Ballinger, Cambridge, Mass.

Cornes, R. and Sandler, T. 1986. The Theory of Externalities, Public Goods, and Club Goods. Cambridge, New York, NY.

Dunlap, R. E. and Van Liere, K. D. 1978. The New Environmental Paradigm. Journal of Environmental Education 9: 10-19.

Dwyer, J. F. and Bowes, M. D. 1979. Benefit-Cost Analysis for Appraisal of Recreation Alternatives. Journal of Forestry 77: 145-47.

Dyer, A. A. and Hof, J. G. 1979. Comment on "Benefit-Cost Analysis for Appraisal of Recreation Alternatives." Journal of Forestry 77: 147-48.

Fisher, A. C. and Krutilla, J. C. 1972. Determination of Optimal Capacity of Resource-Based Recreational Facilities. Natural Resource Journal 12: 417-44.

Freeman, A. M. and Haveman, R. H. 1979. Congestion, Quality Deterioration, and Heterogeneous Tastes. Journal of Public Economics 8: 225-32.

Geller, J. and Lasley, P. 1984. The New Environmental Paradigm: A Reexamination. Paper presented at the annual meeting of the Midwest Sociological Society, April 18-21, 1984, Chicago, Illinois.

Glejser, H. 1969. A New Test for Heterscedasticity. Journal of American Statistic Association 64: 316-323.

Hillman, A. L. and Swan, P. L. 1983. Participation Rules for Pareto Optimal Clubs. Journal of Public Economics 20: 55-76.

Johnston, J. 1984. Econometric Methods. 3rd ed. McGraw-Hill Book Co., New York.

Just, R. E., Hueth, D. L. and Schmitz, A. 1982. Applied Welfare Economics and Public Policy. Prentice-Hall, Englewood Cliffs, N.J.

McConnell, K. E. 1977. Congestion and Willingness to Pay: A Study of Beach Use. Land Economics 53, No. 2: 185-195.

Ministry of Construction, Korea. 1984. Plan of Book Han San National Park. Ministry of Construction, Seoul, Korea.

Oakland, W. H. 1972. Congestion, Public Goods and Welfare. Journal of Public Economics 1: 339-57.

Randall, A., Ives, B. and Eastman, C. 1974. Bidding Games for Valuation of Aesthetic Environmental Improvements. Journal of Environmental Economics and Management 1: 32-149.

Randall, A. and Peterson, G. L. 1982. The Valuation of Wildland Benefits: An Overview. pp. 1-50. In Valuation of Wildland Resource Benefits, G. L. Peterson and A. Randall, eds. Westview Press Inc., Boulder, Colorado.

Rothenberg, J. 1970. The Economics of Congestion and Pollution: An Integrated View. American Economic Review 60: 114-21.

Rosenthal, D. H. and Walsh, R. G. 1986. Hiking Values and the Recreation Opportunity Spectrum. Forest Science 32, No. 2: 405-415.

Samuelson, P. A. 1954. The Pure Theory of Public Expenditure. Review of Economics and Statistics 36: 387-89.

Smith, V. K., Desvousges, W. H. and Fisher, A. 1986. A Comparison of Direct and Indirect Methods for Estimating Environmental Benefits. American Journal of Agricultural Economics 68: 280-90.

Stankey, G. H. 1972. A Strategy for the Definition and Management of Wilderness Quality. pp. 88-114. In Natural Environments: Studies in Theoretical and Applied Analysis, J. V. Krutilla, ed. Johns Hopkins, Baltimore.

Wagar, J. 1964. The Carrying Capacity of Wildlands for Recreation. Forest Science Monograph 7.

Walsh, R. G., Miller, N. P. and Gilliam, L. O. 1983. Congestion and Willingness to Pay for Expansion of Sking Capacity. Land Economics 59: 195-210.

# VIII. APPENDIX

Summer 1987

Book Han San Congestion Study
Questionnaire

| | |
|---|---|
| Interviewer ID | ______ |
| Date | ______ |
| Time | ______ |
| Site | ______ |

Introduction

Hello, I am conducting a questionnaire survey about user's recreational experience in the Book Han San National Park. In specific, this study is a look at the effects of congestion that may be occurring in this park. I would like to ask you some questions about you recreational experiences in this park.

An information you give us will be kept strictly confidential and will be reported as part of a statistical summary.

This interview will take 15-20 minutes. I would like to ask you to help me by participating in this survey.

## A. RECREATIONAL BEHAVIOR

A-1. How many times within the past 12 months did you visit any of the mountains around Seoul such as Book Han San, Do Bong San, Kwan Ak San, Soo Rak San?

A-2. Which activities listed below did you participate most often at these sites during the last 12 months?

Walking -------------------------- 01

Hiking --------------------------- 02

Picnicking ----------------------- 03

Camping -------------------------- 04

Rock climbing -------------------- 05

Bird/wildlife observation -------- 06

A-3. What is the approximate distance from your residence to the park?

Less than 1 kilometer ------------ 01

1-3 kilometer -------------------- 02

3-5 kilometer -------------------- 03

5-10 kilometer ------------------- 04

10-15 kilometer ------------------ 05

15-20 kilometer ------------------ 06

More than 20 kilometer ----------- 07

A-4. The usual method of getting to this park is:

Walking ------------------------- 01

Public transportation ------------ 02
(bus and/or subway)

Taxi ---------------------------- 03

Car ----------------------------- 04

Others -------------------------- 05

A-5. How long does it usually take to get to this park?

Less than 10 minutes ------------ 01

10-20 minutes ------------------- 02

20-30 minutes ------------------- 03

30-40 minutes ------------------- 04

40-50 --------------------------- 05

50-60 --------------------------- 06

60-90 --------------------------- 07

More than 90 minutes ------------ 09

A-6. What was your transportation cost to get to this park?

W________________ Won

A-7. How long are you going to stay (or have stayed) in this park?

Less than 1 hour ---------------- 01

1-2 hours ----------------------- 02

2-4 hours ----------------------- 03

4-6 hours ----------------------- 04

## B. ATTITUDE TOWARD ENVIRONMENT

Now we would like your opinions on some statements regarding the use of land. After I read a statement, tell me whether you (1) strongly agree, (2) agree, (3) feel neutral, (4) disagree, or (5) strongly disagree.

| | | | | | | |
|---|---|---|---|---|---|---|
| a. | We are approaching the limit of the number of people the earth can support .................. | 1 | 2 | 3 | 4 | 5 |
| b. | The balance of nature is very delicate and easily upset ..... | 1 | 2 | 3 | 4 | 5 |
| c. | Mankind was created to rule over the rest of nature ............ | 1 | 2 | 3 | 4 | 5 |
| d. | When humans interfere with nature it often produces disastrous consequences .................. | 1 | 2 | 3 | 4 | 5 |
| e. | The earth is like a spaceship with only limited room and resources ..................... | 1 | 2 | 3 | 4 | 5 |
| f. | Humans have the right to modify the natural environment to suit their needs .................. | 1 | 2 | 3 | 4 | 5 |
| g. | Humans have the right to modify the natural environment to suit their needs .................. | 1 | 2 | 3 | 4 | 5 |
| h. | There are limits to growth beyond which our industrialized society cannot expand ................ | 1 | 2 | 3 | 4 | 5 |
| i. | Plants and animals exist primarily to be used by humans ... | 1 | 2 | 3 | 4 | 5 |
| j. | Mankind is severely abusing the environment .................. | 1 | 2 | 3 | 4 | 5 |
| k. | To maintain a healthy economy we will have to develop a "steady state" economy where industrial growth is controlled .................. | 1 | 2 | 3 | 4 | 5 |

1. Humans need not adapt to the natural environment because they can remake it to suit their needs 1 2 3 4 5

## C. EFFECTS OF CONGESTION

Generally it can be said that if a mountain park is congested by too many users, the satisfaction of users of the park will be decreased. The main purpose of this survey is to measure the effect of congestion on users of this park.

This video tape is showing five different levels of user density of two representative trails, from Density 1 to Density 5:

Density 1. In this level of user density, there is one other party or no other parties in sight and there is no noise.

Density 2. In this level of user density, there are 2-3 parties of other users in sight and the noise level is low.

Density 3. In this level of user density, other users are visible in sight and their conversations can be distinguishable.

Density 4. This level of user density shows many users hiking along the trail in single file and the surroundings are noisy.

Density 5. This level of user density shows that the trail is so crowded that occasionally walking is hindered, and the level of noise is so high that conversation within a party can be difficult.

C-1. In terms of this video tape, from density 1 to density 5, how would you rate the user density of the Book Han San National Park at the present time?

Density 1 --------------- 01

Density 2 --------------- 02

Density 3 --------------- 03

Density 4 --------------- 04

Density 5 --------------- 05

C-2. What was your anticipation of user density of this park in terms of this video tape before you leave your home?

Density 1 --------------- 01

Density 2 --------------- 02

Density 3 --------------- 03

Density 4 --------------- 04

Density 5 --------------- 04

Generally it can be said that the pleasure or satisfaction derived from a recreational experience and lessening of this kind of satisfaction due to congestion are psychological phenomena which are difficult to represent quantitatively. However, scientific analysis requires quantification of the psychological phenomena.

In this need, we would like to ask you the maximum amount of your willingness to pay an entrance fee for a visitation of the park.

Again, I assure you than any information you give us is going to be used as a basic data for scientific analysis but not as a basis of entrance fee assignment.

C-3. Suppose that the user density of this mountain park is similar to "Density 4" in terms of the video tape shown, what is the maximum amount you would be willing to pay as entrance fee for a visitation?

W______________Won

Reference: Example of entrance fee for some recreational facilities.

| | |
|---|---|
| Movie theater: | 3,000-3,500 Won |
| Palace: | 550-1,800 Won |
| Indoor swimming pool: | about 4,000 Won |
| Tennis court: | 5,000-7,000 Won/court, hour |
| Grandchildren's Park: | 800 Won |
| Folk village: | 2,500 Won |
| Natural farm: | 2,500 Won |

C-4. If user density increases from "Density 4" to "Density 5, how much will dollars be decreased from the amount you answered, question C-3, as you are willing to pay per visitation.

W_____________ Won (If any amount, go to C-5,
If zero amount, go to C-8):

User density of this park does not affect the quality of your recreational experience of this park?

Yes ---------------- 01 (Go to C-5)

No ---------------- 02

C-5. If the user density decreases from "Density 4" to "Density 3," how much more are you willing to pay in addition to the amount you said you were willing to pay as entrance fee.

When the user density is "Density 4"?

W __________Won (If zero amount, go to C-8)

C-6. If the user density decrease further from "Density 3," to "Density 2," how much more are you willing to pay in addition to the amount you said you were willing to more for the question C-5?.

W _________Won (If zero amount, go to C-8)

C-7. If the user density decrease further from "Density 2" to "Density 1," how much more are you willing to pay as entrance fee in addition to the amount you said you were willing to pay for question C-6?

W _________Won (If zero zmount, go to C-8)

C-8. Which of these reasons best describes why you answers the way you did.

not enough information ------------- 01

did not want to place money value ------------------------ 02

Objected to the way question was presented --------------------- 03

That is what it is worth ----------- 04

Other ____________ (specify) ----------------- 05

## D. DEMOGRAPHIC DATA

D-1. Sex

Male ------------- 01

Female ----------- 02

D-2. Age

Less than 19 years old ------------ 01

20-24 years old ------------------- 02

25-29 years old ------------------- 03

30-34 years old ------------------- 04

35-39 years old ------------------- 05

40-44 years old ------------------- 06

45-49 years old ------------------- 07

50-54 years old ------------------- 08

55-59 years old ------------------- 09

60-64 years old ------------------- 10

More than 65 years old ------------ 11

D-3. Education

None ------------------- 01

6 years ---------------- 02

9 years ---------------- 03

12 years --------------- 04

14 years --------------- 05

More than 16 years ----- 06

D-4. Occupation

__________________________________________________

(If retired, primary occupation before retirement)

D-5. Family size

___________person

D-6. Family income per month

Under 200,000 Won -------------- 01

200,000-400,000 Won ------------ 02

400,000-600,000 Won ------------ 03

600,000-800,000 Won ------------ 04

800,000-1,000,000 Won ---------- 05

More than 1,000,000 Won -------- 06

D-7. How many days off do you have per month?

___________days

D-8. What do you feel about your health?

Very healthy ----------- 01

Healthy ---------------- 02

Feel neutral ----------- 03

Bad health ------------- 04

Very bad health -------- 05

D-9. What is your address?

___________________Ku ________________ Dong

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